SYLLABUS

1. Data about the program of study

1.1 Institution	Technical University of Cluj-Napoca
1.2 Faculty	Faculty of Electronics, Telecommunications and information Technology
1.3 Department	Bases of Electronics
1.4 Field of study	Electronic Engineering, Telecommunications and Information Technologies
1.5 Cycle of study	Bachelor of Science
1.6 Program of study / Qualification	Applied Electronics / Engineer
1.7 Form of education	Full time
1.8 Subject code	39.00

2. Data about the subject

2.1 Subject name	Digital Signal Processing						
2.2 Subject area	Theoretical area Methodical area Analytic area						
2.3 course responsible	Assoc.Prof. Lăcrimioara-Romana GRAMA, PhD eng – Lacrimioara.Grama@bel.utcluj.ro						
2.4 Teachers in charge with laboratory	Assoc.Prof. Lăcrimioara-Romana GRAMA, PhD eng – Lacrimioara.Grama@bel.utcluj.ro Alexandru Cristian LODIN, PhD eng – Alexandru.Lodin@bel.utcluj.ro						
2.5 Year of study	III	2.6 Semester	2	2.7 Assessment	E	2.8 Subject category	DD/DI

3. Estimated total time

3.1 Number of hours per week	4	Of which: 3.2 course	2	3.3 laboratory	2
3.4 Total hours in the curriculum	56	Of which: 3.5 course	28	3.6 laboratory	28
Distribution of time					hours
Manual, lecture material and notes, bibliography					10
Supplementary study in the library, online specialized platforms and in the field					1
Preparation for seminars / laboratories, homework, reports, portfolios and essays					2
Tutoring					3
Exams and tests					3
Other activities: NA					0

3.7 Total hours of individual study	19
3.8 Total hours per semester	75
3.9 Number of credit points	3

4. Pre-requisites (where appropriate)

4.1 curriculum	Mathematical Analysis, Linear Algebra, Applied Informatics, Special Mathematics, Differential Equations, Electronic Devices, Computer Aided Graphics, Signals and Systems, Digital Integrated Circuits, Circuits Analysis and Synthesis, Systems with Digital Integrated Circuits, Software Engineering
4.2 competence	Knowledge of mathematics, signal theory, electronic devices, digital integrated circuits; use of MATLab development environment

5. Requirements (where appropriate)

5.1. for the course	Amphitheatre (with blackboard and video projector), Cluj-Napoca
5.2. for the seminars/ laboratories/ projects	Laboratory (with computers and blackboard), Cluj-Napoca

6. Specific competences

Professional competences	C2 Applying the basic methods for signal acquisition and processing • C2.1 Temporal, spectral and statistical characterization of signals • C2.2 Explaining and interpreting the methods of acquisition and processing of signals • C2.3 Use of simulation environments for signal analysis and processing • C2.4 Use of the specific method and tools for signal analysis C3 Application of the basic knowledge, concepts and methods regarding the architecture of computing systems, microprocessors, microcontrollers, programming languages and techniques • C3.4 Development of programs for a general and / or specific programming language, starting from the specification of the requirements and until the execution, debugging and interpretation of the results in correlation with the processor used • C3.5 Projects involving hardware (processors) and software (programming) components
Cross competences	CT1. Methodical analysis of problems encountered in the activity, identifying the elements for which there are established solutions, thus ensuring the fulfillment of professional tasks

7. Discipline objectives (as results from the key competences gained)

7.1 General objective	Development of professional skills in the field of • signal and system analysis, • digital filter design

7.2 Specific objectives	• Assimilating theoretical knowledge regarding signal and system analysis, digital filter design using appropriate software tools (MATLab)
	• Interpretation of specific phenomena from signal analysis using
	  ○ Fourier transform,
	  ○ discrete Fourier transform,
	  ○ fast Fourier transform
	• Obtaining the skills needed to implement and evaluate the performance of digital filters

8. Contents

8.1 Lecture (syllabus)	Teaching methods	Notes
1. Course overview. Introduction to digital signal processing	Presentation, heuristic conversation, exemplification, problem presentation, teaching exercise, case study, demonstration, questioning	Use of blackboard and video projector
2. Discrete-time signals and systems		
3. Analysis of discrete-time linear time invariant systems		
4. Direct-form implementation of discrete-time systems. Linear time invariant systems characterized by difference equations		
5. The z-transform		
6. z-domain analysis of LTI systems. Fourier series for discrete-time periodic Signals		
7. Fourier transform for discrete-time aperiodic signals and frequency domain characteristics of LTIS		
8. Discrete Fourier transform		
9. Fast Fourier transform		
10. Implementation of FIR systems. Implementation of IIR systems		
11. LTIS as frequency selective filters. Linear-phase FIR filters		
12. Design of digital filters (FIR and IIR)		
13. Quatization		
14. Digital signal processing summary. Exam example		

Bibliography

[1]. C. Rusu, L. Grama, *Lecture notes in digital signal processing*, Ed. Risoprint, 2009.
[2]. J. G. Proakis, D. G. Manolakis, *Digital signal processing – principles, algorithms and applications*, Pearson, 2013.
[3]. C. Rusu, *Prelucrarea numerică a semnalelor*, Ed. Risoprint, 2002.
[4]. C. Rusu, *Prelucrări digitale de semnale*, Ed. Risoprint, 2000.
[5]. Discipline web page (lecture slides (password required), solved problems, proposed problems) – http://sp.utcluj.ro/Teaching_IIIEA.html
[6]. S. L. Marple Jr., *Digital Spectral Analysis*, Dover Publications, 2nd ed, 2019.
[7]. R. H. McClellan, R. Schafer, M. Yoder, *DSP First*, Pearson, 2nd ed, 2015.
[8]. R. Allred, *Digital Filters for Everyone*, Creative Arts & Sciences House, 3rd ed, 2015.
[9]. S. Smith, *Digital Signal Processing: A Practical Guide for Engineers and Scientists*, Newnes, 1st ed, 2013.
[10]. A. V. Oppenheim, *Discrete-Time Signal Processing*, Pearson, 3rd ed, 2009.
[11]. S. Mitra, *Digital signal processing – a computer-based approach*, McGraw Hill, 2006.

8.2 Seminar / laboratory / project	Teaching methods	Notes
1. Introduction to MATLab	Conversation, explanation, case study, practical demonstration, debate, surveying, questioning, teamwork	Use of PCs, specific software and laboratory guide for teaching, blackboard
2. Discrete-time signals		
3. Sampling of analog signals		
4. Discrete-time linear time-invariant systems		
5. Fourier transform and Discrete Fourier transform		
6. Linear and circular convolution		
7. Practical evaluation from laboratories 1 - 6 (laboratory test): 30 minutes for each student		
8. Finite impulse response filters. Design method		
9. Discrete-time linear time-invariant systems as frequency selective filters		
10. Infinite impulse response filters. Indirect design methods		
11. Quantization of digital filter coefficients		

12. Practical evaluation from laboratories 8 - 11 (laboratory test): 30 minutes for each student. Responses to questions		
13. Seminar		
14. Seminar		

Bibliography

[1]. L. Grama, *Digital signal processing – laboratory guide*, Ed. UTPRESS, 2014.
[2]. L. Grama, C. Rusu, *Prelucrarea numerică a semnalelor – aplicaţii şi probleme*, Ed. UTPRESS, 2008.
[3]. L. Grama, A. Grama, C. Rusu, *Filtre numerice – aplicaţii şi probleme*, Ed. UTPRESS, 2008.
[4]. Discipline web page (laboratory examples and exercises) – http://sp.utcluj.ro/Teaching_IIIEA.html
[5]. S. L. Marple Jr., *Digital Spectral Analysis MATLAB® Software User Guide*, Dover Publications, 2019.
[6]. L. Chaparro, *Signals and systems using MATLAB*, Academic Press, 2nd ed, 2014.
[7]. M. X. Cohen, *Fundamentals of time-Frequency analyses in Matlab/Octave*, sinc(x) Press, 1st ed, 2014.

9. Bridging course contents with the expectations of the representatives of the community, professional associations and employers in the field

The discipline content and the acquired skills are in agreement with the expectations of the professional organizations and the employers in the field, where the students carry out the internship stages and/or occupy a job (in the field of signal analysis, and of design, simulation and testing digital system), and the expectations of the national organization for quality assurance (ARACIS).

10. Evaluation

Activity type	10.1 Assessment criteria	10.2 Assessment methods	10.3 Weight in the final grade
10.4 Course	The level of acquired theoretical knowledge and practical skills	**B** – Continuous formative evaluation (classes attendance and responses to questions during lecture class) **WE** – Summative evaluation written exam (problems solving)	-B, max. 2 pct. -WE, max. 10 pct., 60%
10.5 Seminar /Laboratory	The level of acquired knowledge and abilities	**PE** – 2 formative evaluation tests (practical lab exam – exercises must be implemented in MATLab) • the grades obtained on these tests also consider the activity during the semester (problem solving and implementation; responses to questions)	-PE1, max 10 pct., 20% -PE2, max 10 pct., 20%
10.6 Minimum standard of performance			

Quality level:

Minimum knowledge:

- Knowledge of the main type and properties of discrete-time signal and systems
- Knowledge of the main transforms used for digital signal processing

Minimum competences:

- Apply methods of analysis and synthesis of discrete-time signals and systems
- Design digital filters for different applications
- Interpret the data obtained from analysis of discrete- time signals and systems

Quantitative level:

- $WE \geq 4$ and $0{,}6WE + 0{,}2PE1 + 0{,}2PE2 \geq 4.5$
- Final grade = $0{,}6(WE+ B) + 0{,}2PE1 + 0{,}2PE2$

Date of filling in:	Responsible	Title surname NAME	Signature
29.09.2019	Course	Assoc.Prof. Lăcrimioara-Romana GRAMA, PhD eng.	
	Applications	Assoc.Prof. Lăcrimioara-Romana GRAMA, PhD eng. Alexandru Cristian LODIN, PhD eng.	

Date of approval in the Department of Bases of Electronics _____	Head of Department Prof. Sorin HINTEA, PhD Eng.
Date of approval in the Council of Faculty of Electronics, Telecommunications and Information Technology _____	Dean Prof. Gabriel OLTEAN, PhD Eng.